REMARKS

These Remarks are in reply to the Office action mailed December 28, 2006.

I. Status of Claims

Claims 2-5, 7-11, and 13-19 are pending in the application. Claims 2-5, 7-11, and 13-19 were rejected under 35 USC 103(a) as being unpatentable over Noda et al., US Patent No. 6,905,963. Claim 14 is cancelled in this response.

II. 35 USC 103(a) Rejections, Noda et al.

Claims 2-5, 7-11, and 13-19 were rejected under 35 USC 103(a) as being unpatentable over Noda et al. Claims 2-5 depend from independent claim 17, claims 7-11 depend from independent claim 18, and claims 13-19 depend from independent claim 19.

As amended, claim 17 recites a method for depositing a doped polysilicon film comprising: providing a surface; and substantially simultaneously flowing SiH_4 and BCl_3 over the surface at a temperature between about 460 and about 500 degrees Celsius under conditions that achieve an average concentration in the doped polysilicon film of between about 7×10^{20} and about 3×10^{21} boron atoms per cubic centimeter, wherein the doped polysilicon film is polycrystalline as deposited. Independent claims 18 and 19 also both include the limitation that the dopant concentration in the polysilicon film is between about 7×10^{20} and about 3×10^{21} boron atoms per cubic centimeter, as well as the same temperature range.

The Examiner points to Noda et al., in which SiH_4 and BCl_3 are flowed to deposit a boron-doped silicon film. Noda et al. disclose deposition conditions to form an *in situ*

doped silicon film, but do not disclose the concentration of boron in the resulting film. The Examiner asserts:

> It is the examiner's position that based on the arguments provided in the applicant's previous response, the appropriate boron concentration must be present.

The Examiner believes that the concentration of Noda et al. is the same as the concentration recited in the claims. The deposition temperatures described by Noda et al. are not the same as recited in the claim, but the Examiner finds it would have been obvious "to have selected the portion of Noda's temperature range that corresponds to the claimed range."

Applicants will show that the films formed by Noda et al. have boron concentrations *higher* than the claimed range. Applicants will further show that Noda et al. do not teach flowing an inert gas during deposition, as recited in dependent claims 4 and 8.

Boron concentrations of Noda et al. films are outside the claimed range

Noda et al. gives several embodiments. Each will be addressed.

In example 1 (col. 6, lines 20-67 and Fig. 4), Noda et al. teach flowing 500 sccm of SiH_4 and 5 sccm of BCl_3 at a range of deposition temperatures, preferably at 480°C, and at a pressure of 70 Pascal (525 mTorr).

A declaration under 37 CFR §1.132 by S. Brad Herner, first named inventor of the present application, is included with this correspondence. In this declaration (at item 1), Dr. Herner asserts his belief that the deposition conditions of example 1 of Noda et al. will produce a doped silicon film having a concentration of about 5×10^{21} boron atoms/cm^3, well above the claimed range of between 7×10^{20} and 3×10^{21} boron

atoms/cm^3. This conclusion is based on data presented in two papers: S.B. Herner and M.H. Clark, "Silicon deposition from BCl_3/SiH_4 mixtures: Effect of very high boron concentration on microstructure," *J. Vac. Sci. Tech. B* 22(1) pp. 1-5 (2004); and in S.B. Herner et al., "Low resistivity p^+ polycrystalline silicon deposition at low temperatures with SiH_4/BCl_3," *Electrochemical and Solid State Letters* 7, G108-G111 (2004), both included as Exhibit A.

In example 2 of Noda et al., deposition temperature is between 400 and 420 degrees C (col. 7, lines 21-22, line 57), below the claimed range.

Example 3 discusses equipment and does not present new deposition conditions. In example 4, Noda et al. teach flow rates of 500 sccm of SiH_4 and 0.5 to 22.4 sccm of BCl_3, at deposition temperatures of 390 and 450°C, and at a pressure of 70 Pascal (~525 mTorr). Again, this temperature range is below the claimed range. In addition, in his declaration, Dr. Herner asserts (at item 2) that these conditions will produce a silicon film having a boron concentration of about 4×10^{21} atoms/cm^3, again above the claimed range.

Further evidence that the films produced by the methods of Noda et al. have boron concentrations higher than the claimed ranges is found in Fig. 9, which shows resistivities (what Noda et al. call specific resistance) of various boron-doped silicon films.

Boron is added to silicon, a semiconductor, to increase its conductivity, and, in conventional concentrations, as the boron concentration in silicon increases, it becomes more conductive; i.e. its resistivity decreases. However, as shown in Herner et al. (JVST B), when boron concentration gets very high, exceeding 3×10^{21} boron atoms/cm^3,

resistivity of the film actually begins to *increase*. The Herner et al. (JVST B) paper (in Table 1) shows that at a boron concentration of 7 x 10^{20} atoms/cm^3 (at the bottom of the claimed range), the resulting polysilicon film has a resistivity of 4320 μΩ cm. At a higher boron concentration of 2 x 10^{21} (near the top of the claimed range), the resulting polysilicon film has a resistivity of 3260 μΩ cm. These resistivities can also be expressed as 0.00432 Ω cm and 0.00326 Ω cm. In contrast, the resistivities of the films formed by Noda et al., as shown in Fig. 9, are mostly around 7.5 μΩ cm. This resistivity is more than 1000 times the resistivity at 2 x 10^{21} boron atoms/cm^3, within the claimed range. As Dr. Herner asserts in his declaration (at item 3), the resistivities in Fig. 9 of Noda et al. indicate that the silicon films of Noda et al. have boron concentration either below 1 x 10^{20}/cm^3 or above 6 x 10^{21}/cm^3, both concentrations well outside of the claimed range.

Noda et al. do not disclose an inert gas flowed during deposition

Applicants further note that claim 4, which depends indirectly from independent claim 17; and claim 8, which depends indirectly from claim 18, both include the limitation that an inert gas is flowed over the surface with the SiH_4 and BCl_3. Their dependent claims 5 and 10, respectively, add the limitation that the inert gas is helium. Noda et al. at no point teach flowing helium, or any other inert gas, with SiH_4 and BCl_3. As described in the present application, for example at paragraph [0042], diluting the BCl_3 with an inert gas improves mixing and dopant uniformity.

Applicants note that Noda et al. teach flowing nitrogen, an inert gas, into the chamber. But nitrogen is flowed *before* the flow of SiH_4 and BCl_3 is begun and after it is completed, not at the same time. At col. 6, from line 2-4, Noda et al. explain that after loading the furnace, "the reaction furnace 11 is evacuated … and N_2 purge gas is fed into

the reaction furnace 11 to remove moisture ..." Only after this purge does flow of SiH_4 and BCl_3 begin, as at col. 6, line 7: "***Subsequently*** SiH_4 and BCl_3 are supplied ..."

A purge gas, presumably nitrogen, is introduced again, as at col. 6, line 12, but only after deposition is complete: "***After the completion of film depositing***, the supply of the reaction gas is cut off and a cycle purge operation is performed ..."

There is no teaching in Noda et al. to flow nitrogen, or any other inert gas, *with* SiH_4 and BCl_3 *during* deposition to improve mixing. Thus claims 4-5 and 8-11, which include this limitation, additionally distinguish over the teachings of Noda et al.

In summary, both the conditions during deposition described by Noda et al. and the resistivities of the resulting silicon films lead Dr. Herner to conclude, in the attached declaration, that the films of Noda et al. have dopant concentrations substantially higher than those recited in any of independent claims 17-19. Further, Noda et al. fail to teach flowing an inert gas with SiH_4 and BCl_3 to improve mixing.

CONCLUSION

In view of the preceding Remarks, Applicants submit that this application is in condition for allowance. Reconsideration is respectfully requested. If objections remain, Applicants **respectfully request an interview.** In the event that objections remain, the Examiner is asked to contact the undersigned agent at (408) 869-2921.

Respectfully submitted,

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